Ecosystem pathogens : A view from the centre (east)

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Introduction

In 1846 to 1851 over a million Irish died, and a million more emigrated, starting a trend which kept the population of Ireland small and the semi-natural ecosystems of Ireland more or less intact, or as intact as a landscape depleted by the British Navy and the Industrial Revolution could be. These deaths and population movements were the result of the Irish Potato Famine, caused by the impact of *Phytophthora infestans* on the Irish potato crop, the introduced potato having become the staple of Irish peasant diet. This syndrome, of an introduced food staple being subject to massive infestation and destruction, is not unknown and may well increase in the next decades as global diversity decreases.

What is interesting, in the context of today's discussions, is that this fungal attack, causing dysfunction to the main Irish agroecosystem, actually saved the Irish landscape, and made it what it is today—one of the best preserved of the European landscapes. The other feature of interest is the candidate of destruction, which is a species of one of the key genera of concern to remaining species-rich Australian ecosystems—*Phytophthora*. Of course, much has now been confused by the misleading use of the term "dieback", being a general phenomenon of arborescent shrubs and trees wherever there are ecosystem stresses. Our focus is on one major, insidious, and relatively unrecognised threat, dieback and die-off caused by fungal attack. Although you will traverse a broader coverage during your discussions today, I want to particularly focus on *Phytophthora cinnamomi*, because it is listed as one of five key threatening processes under the 1992 Federal Endangered Species Act.

Major problem syndromes and areas

In the twentieth century, *Phytophthora* has had a major affect on industries such as nurseries, horticulture, cut flowers, field crops and pastures. In Australia, *Phytophthora* was first recognised as a major problem for flora and fauna with the onset of forest dieback in the jarrah forests of Western Australia and in the mixed eucalypt forests of Eastern Australia.

It has only been more recently, however, that *Phytophthora* has been recognised as having a major impact on Australian biodiversity. In particular *P. cinnamomi* has been identified as causing major ecosystem disruption in the species rich communities of southern Western Australia. In addition cool temperate rainforests, heathlands and the understorey of dry sclerophyll woodlands are affected in Tasmania, Victoria and New South Wales. In Northern Australia, *Phytophthora* is reported from tropical rainforest, low sclerophyll shrub woodlands, mangroves and heathland. The scale of infestation in South Australia may be only now becoming apparent, with areas such as Kangaroo Island reporting infections.

This insidious pathogen is altering the ecosystems of Australia on a mammoth scale, sometimes in a subtle way, but also dramatically as occurs here in Western Australia. The floristic composition of vegetation communities on a landscape scale are being permanently altered and this is having subsequent impacts on fauna. For example, *Banksia coccinea*, a species highly susceptible to infection by *Phytophthora*, may be a keystone species because of the reliance of birds and small marsupials on its flowers for food.

Relationship with areas of high biodiversity

The effects of *Phytophthora* are most dramatic in areas of high species diversity. In the south-west of Western Australia, for example, it is estimated that 1500 to 2000 species of the estimated 9000 species of vascular plants may be susceptible to infection. Many of these species are highly endemic and have been taken to the edge of extinction. The pathogen is particularly devastating on species from the families of Proteaceae, Papilionaceae, Mimosaceae and Epacridaceae. These families comprise the bulk of species from which the wildflower export and tourism industry relies. For the Proteaceae family, 85% of species found in the Stirling Range National Park have been rated as susceptible to *Phytophthora* (Wills 1993).

Is it possible that areas of high species diversity are more susceptible to *Phytophthora*, or is it simply that it is in these areas that the problem is more apparent because they demonstrate the most stark examples of alterations in community structure? Whatever the answer, the ability of the pathogen to radically reduce the complexity of a community to a relatively fewer number of tolerant species is having a profound affect on the biodiversity of significant regions of Australia.

Many of the species threatened by fungal syndromes in this State, and indeed in the Eastern States, are either poorly known or not yet subject to taxonomic description. It is axiomatic that there are many species becoming greatly diminished, or extinct, without ever being recognised. Now that clearing of land has become recognised as a major problem for biodiversity conservation, it is ironic that the remaining uncleared areas are being threatened by these syndromes. But is it really serious? Is there not so much redundancy (Walker 1992) in these species-rich systems that

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the loss of a few, albeit colourful, species will not really be of concern? I pose this as the kind of rhetorical question that will be asked of us by senior bureaucrats and politicians.

Considerations for management at a national level

There are important considerations for a national approach to this pandemic pathogen. These include:

- continuing to develop strategies to control the problem in the short to medium term through effective hygiene, the development of control methods such as the use of phosphonate, and improved prediction and mapping of occurrence of incidence;
- investigating longer term control options that may become available;
- improving communication between agencies and institutions;
- conducting research so that advancements and strategies can be rapidly applied;
- developing a national approach to identifying gaps in knowledge and targeting research towards filling those gaps;
- co-ordinating research that no single agency has the resources or expertise to conduct on its own;
- ensuring that limited resources are well targeted and that the effort is complimentary rather than involving duplication;
- investigating novel approaches to control and management of *Phytophthora* and liaising with international experts and agencies.

Linkage of the problem

The problem of *Phytophthora* has common threads of economic loss and ecosystem breakdown across Australia. However, the relative impact in the various regions of Australia differs. For example, where a complex understorey exists, with associated dependant fauna, ecosystem damage comes from loss of floristic and structural richness leading in turn to loss of faunistic richness. Where death of the overstorey is the most apparent symptom, there can be a resultant change in understorey structure from reduced competition. Climate, geology, soils and the resultant vegetation communities are important factors in determining the relative impact of *Phytophthora* from the north of Australia to Tasmania and the south-west of Western Australia.

The number of researchers involved with *Phytophthora* in natural and agroecosystems around Australia is about 150, which includes research staff, technicians and students. Approximately 75% of the researchers work in Western Australia, Queensland and Victoria. Many horticultural crops, and even subterranean clover, are threatened by *Phytophthora* species. But six species, especially *P. cinnamomi* and *P. megasperma*, are of particular threat to the south coast of Western Australia. In economic terms (wildflowers), the problem could be a loss of upwards of $50 million. But, it is the incalculable damage to the species rich ecosystems which is of prime concern. How do you measure the change from one of the worlds most species-rich shrublands to a bland covering of grasses, sedges and restioids?

In National Parks and State Forests, quarantine of diseased forest is the main strategy for control in both Western Australia and Victoria. Vehicle check-points and washdown, as well as logging practices which minimise disease spread are other strategies employed. There appears, however, no management practice which is totally successful at eradicating disease originating from infestation by *Phytophthora*.

Given that, research priorities should attempt to focus on Integrated Pest Management (IPM), and yet there seem to be demands from the community for biocontrol or resistance for breeding as the leading research efforts (Cahill 1993). Recent work in Western Australia particularly focuses on the use of phosphorous acid to protect individual trees, and small areas of ecosystems of high conservation value. Other groups have suggested that biocontrol may be feasible, or that hypovirulence could be induced into some populations. Despite these potential developments, the clear message from the current dire situation is that there is no one cure, and that IPM is the only sensible way to go.

Role of the Australian Government

The role of the Australian Government is to promote a national approach and facilitate research and management action. This has been achieved to date through funding and promoting communication between the various parties responsible for research and management.

The Australian Government also has the role of discharging its legislative responsibilities under the *Endangered Species Protection Act 1992* (ESP Act). This new and important legislation tackles endangered species conservation in a number of innovative ways. For example, it provides for the recognition and protection of ecological communities. It also tackles threatening processes, which operate across a range of habitats and affect many species, whether threatened or not. The Act recognises *Phytophthora* as a key threatening process and establishes the premise that a nationally coordinated plan would be of major benefit in tackling the problem. Such a plan must be in place by 1999.

The Commonwealth has significant funding that can be brought to bear on *Phytophthora*, such as from the Endangered Species Program. Important work being funded at present includes the development of disease control by the application of phosphonate, the development of an inexpensive and simple diagnostic test for the presence of *Phytophthora*, the use of GIS for mapping and predicting distribution and severity of disease, and the identification of susceptible taxa and long-term storage of germplasm.

The Commonwealth can also be of assistance by providing research expertise of a high quality to provide direction and support to agencies directly responsible for tackling *Phytophthora*. There are now a number of successful examples of Co-operative Research Centres (CRC) in Australia, where a collaborative and co-operative approach has been employed to tackle important issues such as *Phytophthora*. Given that Integrated Pest Management appears the only sensible way to tackle the problem, perhaps development of a CRC is a practical and effective way to proceed into an uncertain future. Symposia like this one today are a start on the road to attaining greater certainty.

One final point, which may seem heretical, needs to be posed. Bridgewater & Ivanovici (1992) discuss the phenomenon of "constraint syndromes" on the natural ecosystem, using as exemplars *Drupella* and *Acanthaster* in the marine environment. Are the various fungal syndromes to be discussed today in a similar category? If so, simply solving the problems caused by the fungal species effecting the constraint may not be the whole answer. It would be rather like curing the symptom, rather than the disease. To cure the disease, we suspect a greater understanding is needed of human influences at work in the landscape at large, for broadly-based human-induced change may just be the primary driving forces for the more obvious features such as dieback / dieoff. Just as IPM may be the answer to solving the fungal problem, we may need to combine it with Integrated Landscape Management, to give full effect to our palliative measures.

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